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COMBATING APPLE SCAB  
SPRAYING AND DUSTING EXPERIMENTS  
IN 1922

By WEBSTER S. KROUT

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The scab fungus of the apple affects seriously the McIntosh Red, particularly as it is grown in the eastern apple region of the State. Nowhere in the State has scab yielded completely to the protective spraying and dusting methods commonly followed by apple growers. The Experiment Station started work on disease control in the fall of 1920. The outstanding fact to date is that of a high degree of control even in spite of adverse weather conditions. This bulletin gives the record of the 1922 operations, together with concise recommendations for protective treatment against the disease.

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## BULLETIN No. 214.

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### DEPARTMENT OF BOTANY.

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#### COMBATING APPLE SCAB.

SPRAYING AND DUSTING EXPERIMENTS IN 1922.<sup>1</sup>

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BY WEBSTER S. KROUT.

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#### INTRODUCTION.

The fact of control by both spraying and dusting is outstanding at the end of the second year's field study of this fungous disease. Weather conditions in both 1921 and 1922 were most adverse to successful spraying and dusting, and most favorable to scab infection, yet despite these handicaps almost perfect control was obtained.

These investigations were started in the fall of 1920. In the fall of 1921 a report of the results of the first year's work was published through the Extension Service of the College in a pamphlet entitled "Apple Scab and its Control." This bulletin presents to the practical orchardist a similar report for 1922.

The field work has been conducted in three orchards under the direct supervision of the writer. In three other orchards he was present whenever possible. The spraying experiments were in the orchards of Stephen Sabine of Groton and Harry L. Knights and H. L. Frost of Littleton. The dusting experiments were conducted in the orchards of Harry L. Knights and H. L. Frost of Littleton, A. N. Stowe of Hudson, George A. Marshall of Fitchburg and R. J. Fiske of Lunenburg. Especially helpful was the co-operation of J. W. Ames, superintendent of the Knights farm, Roy C. Wilbur, superintendent of the Frost farm, John J. Collins, superintendent of the Stowe farm, and the officers of the Nashoba Fruit Producers Association.

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<sup>1</sup> The writer is indebted to Prof. A. Vincent Osmun, head of the Department of Botany of the Massachusetts Agricultural Experiment Station, for many helpful suggestions during the progress of this study.

## APPLE SCAB.

Apple scab presents one of the most serious problems of the commercial apple grower of Massachusetts. The disease is caused by a fungus which attacks the leaves, flowers, fruit, pedicels and twigs. It may attack any variety of apples, but is exceptionally severe on the McIntosh.

Every orchardist should endeavor to familiarize himself with the first symptoms of apple scab as they appear on the leaves, so that the disease may not reach the epidemic stage before he realizes the danger. Scab usually appears first on the lower side of the leaves as grayish or olive webby spots or blotches, darker than the normal surface of the leaf. The color deepens with age to dark brown or black. The spots on the upper surface of the leaves are first noticed as yellowish green discolorations, gradually deepening with age through olive brown to black. They are velvety, somewhat definite in outline, smaller than spots on the lower side, and have a tendency to become raised or convex.

*The Causal Fungus.*

The scab fungus passes the winter on the dead leaves, under the trees. In the autumn after the leaves fall the fungus continues growing, penetrating the interior of the leaf. Sometimes, in November, it begins to form the flask-shaped bodies (perithecia) in which mature winter spores (ascospores) are developed by the following spring. During the rainy periods of spring these spores are discharged, and, being extremely light, are carried upward by the air to the under surface of the leaves. The scab spots produced by this infection appear from eight to fifteen days later. These spots, almost as soon as they are noticeable, produce the summer spores in great quantities. These spores cause rapid spread of the disease.

TABLE I.—*Dates of Discharge of Winter Spores and of the First Appearance of Scab in 1921 and 1922.*

|                                            | 1921.    | 1922.   |
|--------------------------------------------|----------|---------|
| First discharge of winter spores . . . . . | April 26 | May 2   |
| First appearance of scab . . . . .         | May 12   | May 18  |
| Last discharge of winter spores . . . . .  | June 10  | June 15 |

During both years the first spots were discovered on the lower side of the leaves at the time of the calyx spray. In other words, the first spots appeared as the petals were dropping.

## SPRAYING PROGRAM FOR 1922.

A series of plots in triplicate were laid off in the three orchards previously mentioned. The sprays used were home-made Bordeaux mixture alone, home-made Bordeaux mixture and liquid lime-sulfur, home-made Bordeaux mixture and dry lime-sulfur, a 4-50 and a 3-50 dry lime-sulfur, liquid lime-sulfur, and liquid lime-sulfur plus lime.

Powdered arsenate of lead, at the rate of 2 pounds to 50 gallons of spray, and 40 per cent nicotine sulfate, at the rate of three-eighths pint to 50 gallons of spray, were used with all the different spray materials in the delayed-dormant, pink and calyx. In the fourth summer spray arsenate of lead was used but the nicotine was omitted.

In the Sabine and Knights orchards the plots were rectangular, 4 rows of 6 trees each, except the check at Sabine's which had 16 trees, and the Bordeaux-dry lime-sulfur plot at Knights' which had 20 trees. In the Frost orchard the plots consisted of single rows of 8 to 11 trees. The data were taken from 5 typical trees of the two middle rows of each plot in the Sabine and Knights orchards; and in the Frost orchard, from 5 typical trees of each row. The trees of each of the three sprayed orchards were approximately twelve years old.

*Treatment of Plots.*

All plots, except the checks, were given the delayed-dormant application. The plots in the Sabine and Knights orchards were sprayed with a 1-10 liquid lime-sulfur plus arsenate and nicotine. The plots in the Frost orchard were sprayed with a 15-50 dry lime-sulfur plus arsenate and nicotine. Plots 1 to 8 were conducted in each of the three orchards. Plots 9 to 11 were conducted only in the Frost orchard. The plots in the Sabine orchard were the only ones given the fifth summer spray. The detailed treatment of plots follows:—

*Plot 1.* — Check, unsprayed with fungicides. The same insecticides were used as on the other plots. A single check plot was used in each of the Sabine and Frost orchards. In the Knights orchard two check plots were necessary, because the Bordeaux plot was located in a separate block of trees.

*Plot 2.* — A 3-10-50 home-made Bordeaux mixture<sup>1</sup> for the pink spray, and a 1-50 liquid lime-sulfur for the calyx and following sprays.

*Plot 3.* — The same as plot 2, except that dry lime-sulfur was substituted for the liquid.

*Plot 4.* — 1-50 liquid lime-sulfur.

*Plot 5.* — 4-50 dry lime-sulfur.

*Plot 6.* — 1-50 liquid lime-sulfur plus 6 pounds of lump lime to 50 gallons of spray.

*Plot 7.* — A 3-10-50 home-made Bordeaux mixture for the pre-pink and pink, and liquid lime-sulfur for the calyx and succeeding sprays.

*Plot 8.* — A 3-10-50 home-made Bordeaux mixture only.

<sup>1</sup> Directions for making Bordeaux mixture may be obtained by applying to the Extension Service, Massachusetts Agricultural College. Ask for Extension Leaflet No. 33.

*Plot 9.* — A 4-50 dry lime-sulfur for the pre-pink, pink and following sprays.

*Plot 10.* — A 3-50 dry lime-sulfur plus arsenate and nicotine.

*Plot 11.* — A 3-50 dry lime-sulfur plus nicotine sprayed on the trees, allowed to dry, and then the arsenate applied.

#### *Time and Manner of Spray Applications.*

TABLE II. — *Time of Application of Sprays for 1921 and 1922.*

| APPLICATION.              | 1921.       | 1922.          |
|---------------------------|-------------|----------------|
| Delayed-dormant . . . . . | April 4-6   | April 13-19    |
| Pre-pink . . . . .        | - -         | April 28-May 3 |
| Pink . . . . .            | April 25-27 | May 3-8        |
| Calyx . . . . .           | May 10-12   | May 16-20      |
| Fourth summer . . . . .   | June 6-8    | June 9-22      |
| Fifth summer . . . . .    | - -         | June 25-31     |

As previously explained, two additional applications, the pre-pink and fifth summer, were made on some of the plots in 1922. Power sprayers which maintained approximately 200 pounds pressure were used, with spray rods equipped with the regular 45° Friend angle nozzles. By holding the rod close to the ground and in such a position as to shoot the sprays upward, the under surface of the lowest leaves was thoroughly covered. As these are the first leaves attacked by the scab fungus, it is exceedingly important that they be well covered at the pre-pink and pink applications.

#### DISCUSSION OF RESULTS OF SPRAYING.

Throughout most of the season weather conditions were exceedingly favorable for scab infection.

It will be noted in Tables IV, V and VI (pages 40 and 41) that all of the sprays gave exceptionally good control. In fact, many of the sprayed plots produced 100 per cent marketable fruit, whereas some of the checks produced fruit 100 per cent scabbed. There was not a single scab-free apple on the 16 check trees in the Sabine orchard, and 95 per cent were so badly scabbed that they were unmarketable. In the Knights orchard the situation was nearly as bad, 96 per cent of the fruit being scabbed and 69 per cent unmarketable. In the Frost orchard infection was not quite as severe, only 41 per cent of the fruit being scabbed.

Only small and probably insignificant differences were found in the results obtained from the different fungicides in so far as control of the scab fungus is concerned.

#### *Importance of the First Spray Applications.*

The dissemination of scab spores is most rapid about the time of the pink application. This is, therefore, the most important spray and should be so timed that it will be on the foliage, blossoms and pedicels of the

blossoms before the winter spores are discharged. Observations of the writer indicate that most growers who fail to control scab apply the pink spray too late in the season.

In some places a pre-pink spray is used in order to make certain that the fungicide is on the leaves before the scab spores are discharged. Explained in the most simple terms, this means setting the pink spray ahead from seven to ten days. It is a spray applied approximately midway between the delayed-dormant and the pink. At that time most of the cluster buds are still closed, and a few only of the most advanced blossom buds show slight amounts of pink. Tables IV, V and VI, plots 7 and 9, show that the series of plots on which the pre-pink spray was applied yielded exceptionally high percentages of both clean and marketable fruit.

If the orchardist were positive that the pink application could be made before the discharge of the winter spores, it would be unnecessary to use a pre-pink spray. The pre-pink application is intended primarily to eliminate this uncertainty connected with the pink treatment. The cost of the spray material at this application is a small item, as the arsenate and nicotine are omitted. As this application has been tested one year only in this State, the writer hesitates to recommend it to the small orchardist. To any orchardist who has three or more days of spraying at the pink application, it is to be recommended without hesitation.

#### *Home-made Bordeaux and Lime-Sulfur.*

A 3-10-50 home-made Bordeaux mixture used alone for all applications russeted the fruit and burned the foliage so badly that its use in this way will be discontinued. Foliage burn due to the Bordeaux was not evident until the latter part of the season.

*For two years, a 3-10-50 home-made Bordeaux mixture for the pink spray, followed by a 1-50 liquid lime-sulfur for the calyx and succeeding sprays, has given the most satisfactory results.* From Tables IV, V and VI it will be seen that this combination in Sabine's orchard produced 98 per cent marketable fruit, but fell slightly lower than some of the other plots in clean fruit. In the Knights and Frost orchards it produced 100 per cent marketable fruit.

Some of the fruit sprayed with the Bordeaux-liquid lime-sulfur combination described above was russeted slightly. The writer questions whether this was caused by the Bordeaux at the pink spray or by natural conditions, as about the same amount of russetting occurred on some of the unsprayed trees. Also, no russetting occurred on similarly treated plots in 1921. The russetting was slight and did not injure the sale of the fruit except where the apples were sold to a fancy trade. In 1921 lime-sulfur burned the blossom buds badly.

A test was made to determine if dry lime-sulfur used with home-made Bordeaux mixture was as effective for the control of scab as the liquid form. Tables IV, V and VI, plots 2 and 3, show that the dry form was practically as good as the liquid, except in the Sabine orchard, where for

some unexplained reason the Bordeaux-dry lime-sulfur plot yielded only 49 per cent clean fruit and 90 per cent marketable fruit. The fact that the total yield of this plot was exceptionally low may justify leaving it out of consideration.

#### *Liquid Lime-Sulfur versus Dry Lime-Sulfur.*

For two years dry lime-sulfur has given as good control of scab as the liquid form (Tables IV, V and VI). Four pounds of the dry form in 50 gallons of water have been used for all sprays except the delayed-dormant in most of the work, but judging from this year's results 3 pounds will give as good results. Some growers use only 2 pounds in 50 gallons, but in the opinion of the writer this is too dilute.

Dry lime-sulfur has the advantage of less bulk, and it is claimed that the fungicidal value is not injured by freezing. Both the dry and liquid forms of lime-sulfur used with lead will burn the foliage under certain conditions, but judging from the data at hand the liquid form seems to burn slightly more than the dry.

#### THE COST OF SPRAYING.

In figuring the cost of spraying the writer has used the data from the experimental plots of 1922. It is assumed that there are 30 twelve-year-old McIntosh trees to the acre. Dry lime-sulfur and insecticides are used as indicated in the suggested spraying schedule for 1923: dry lime-sulfur, 15 pounds to 50 gallons of water for the delayed-dormant, and 4 pounds to 50 gallons of water for the four later applications; powdered lead arsenate, 2 pounds to 50 gallons of spray; and nicotine sulfate, three-eighths pint to 50 gallons of spray. Four gallons of spray are allowed for each tree. The cost of lime-sulfur is placed at 10½ cents per pound; powdered arsenate of lead at 14 cents per pound; and nicotine sulfate at \$14 per gallon. Spraying with either liquid lime-sulfur or Bordeaux mixture costs slightly less than with dry lime-sulfur.

TABLE III.—Cost of Spraying One Acre of Apple Trees.

| APPLICATIONS.                     | MATERIAL.        |                 |                   | LABOR. |        | Total.  |
|-----------------------------------|------------------|-----------------|-------------------|--------|--------|---------|
|                                   | Dry Lime-Sulfur. | Lead Arse-nate. | Nicotine Sulfate. | Man.   | Team.  |         |
| Delayed-dormant . . . . .         | \$3 78           | \$0 67          | \$1 57            | \$0 70 | \$0 30 | \$7 02  |
| Pre-pink . . . . .                | 1 00             | -               | -                 | 70     | 30     | 2 00    |
| Pink . . . . .                    | 1 00             | 67              | 1 57              | 70     | 30     | 4 24    |
| Calyx . . . . .                   | 1 00             | 67              | 1 57              | 70     | 30     | 4 24    |
| Fourth summer . . . . .           | 1 00             | 67              | 1 57              | 70     | 30     | 4 24    |
| Total for five applications . . . | \$7 78           | \$2 68          | \$6 28            | \$3 50 | \$1 50 | \$21 74 |

## DUSTING PROGRAM FOR 1922.

The use of dusts for the control of apple scab is new in this State. Prior to 1921 the writer knew of only one dusting machine in the eastern part of the State, and that was used for dusting peaches. In 1921 dusting experiments were begun by the station in three orchards. The writer and growers who co-operated were inexperienced in the art of dusting, and consequently the dusts were not applied as well as they might have been. As a result, dusting compared very unfavorably with spraying.

In 1922 a number of growers bought dusting machines. With the experience of the previous year, and willingness on the part of growers to co-operate, extensive plans were made to test the efficacy of dusting materials for the control of apple scab. Accordingly, five orchards, previously mentioned, were chosen in which to locate the experiments. Two dusts, sulfur and a copper-lime-arsenate dust, were used in each orchard. Checks were used in all cases. The plots were all large, one of them containing 179 trees. Only McIntosh trees were used.

It will be noticed that there was no nicotine in any of our dusts. Nicotine makes a dust expensive, and the manufacturers state that it is difficult to manufacture a satisfactory sulfur dust high in sulfur with sufficient nicotine in it. As it happened, no nicotine was needed on any of the plots, but it was planned to spray with a nicotine solution or dust with a nicotine dust should infestation with sucking insects become serious.

Five representative trees of each dusted plot in the Marshall and Stowe orchards, 7 in the Knights orchard and 6 in the Frost orchard were chosen from which to take data. Also 3 representative trees of each undusted check in the Marshall and Knights orchards, 2 of one check in the Stowe orchard and 3 of the other (Table VII, plot 12) and 2 in the Frost orchard were chosen from which to take the data (Tables V, VI and VII, pages 40 and 41). The data of the Fiske orchard are not given as the trees were young and the yield exceptionally low.

*Treatment of Plots.*

Plots 13 and 14 in all the orchards were given the regular delayed-dormant spray with lime-sulfur. The plots in the Stowe orchard were given three dust applications,—the pre-pink, pink and fourth summer. The plots in the Frost and Fiske orchards had four applications,—the pre-pink, pink, calyx and fourth summer. The plots in the Knights orchard had five applications,—the pre-pink, pink, calyx, fourth and fifth summer. The plots in the Marshall orchard had nine applications,—the pre-pink, pink, calyx and six subsequent applications. The detailed treatment of plots follows:—

*Plot 12.*—Check untreated with fungicides, but sprayed with the usual insecticides.

*Plot 13.*—Sulfur dusts. The ordinary commercial dusting sulfur without insecticides was used for the pre-pink, fifth, sixth and seventh summer applications.

A sulfur dust, composed of 85 parts sulfur and 15 parts arsenate of lead, was used for the pink, calyx and fourth summer dusts.

*Plot 14.* — Copper-lime-arsenate dust for the pre-pink, pink and fourth summer applications only. An 85-15 sulfur dust was used at the calyx application, and dusting sulfur for treatments after the fourth summer application.

#### *Time and Manner of Application.*

The dusts were applied at approximately the same time as the sprays (Table II). Two different makes of power dusting machines were used. *The dusts were applied from two sides of the trees while the leaves were wet.* Dusting was started at 5 A.M. and continued until about 8 A.M. The best distribution of dust through the tree was accomplished by giving the hose a circular or a quick upward and downward movement. Care was taken to hit the lower leaves, especially at the pre-pink and the pink applications. The engine and duster should be on a low wagon or truck built especially for the purpose, so that the operator may shoot the dusts upward through the tree. Where rows of trees are too close together, this will hinder the operation of the duster.

#### DISCUSSION OF RESULTS OF DUSTING.

In evaluating the results from dusting in 1922 it must be borne in mind that only a single year's work is represented, and that it is, therefore, decidedly unsafe and unsound to draw any conclusions whatever.

The data in Tables V, VI and VII show that the dusts gave excellent control of scab in a year most favorable for the development of the scab fungus. For example, in the Knights orchard the check for the dusts produced only 1 per cent marketable fruit, while the sulfur and copper-lime-arsenate dust plots produced 97 and 99 per cent marketable fruit. In the Frost orchard the check for the dusts produced 68 per cent marketable fruit; the sulfur dust plot, 96 per cent; and the copper-lime-arsenate plot, 97 per cent.

In the Stowe orchard the checks produced from 46 to 48 per cent marketable fruit; the dusted plots, 92 to 97 per cent. Table VII shows that in the Stowe orchard slightly better results were obtained on the younger trees than on the older. This, with the fact that practically all the scabby apples of the dusted plots were found in the tops of the trees, would indicate that the higher the tree the more difficult it is to apply the dust thoroughly. Although the results on the dusted plots were extremely good, it is evident that even better results might have been obtained had the dusts been more thoroughly applied to the topmost parts of the trees.

In several cases where late summer applications of lime-sulfur and dusts were made side by side in the same orchard, the lime-sulfur burned the foliage, while the sulfur dust caused no injury. Later observations showed that where the foliage was burned by the lime-sulfur, from 8 to 20 per cent of the fruit dropped prematurely; while where the sulfur dust was used, practically the entire crop remained on the trees.

It is quite evident that copper-lime-arsenate dust controlled scab more effectively than the sulfur dusts, as in three of four orchards it gave a higher percentage of clean and marketable fruit. *However, it cannot be recommended for apples on account of the russetting of the fruit and the burning of the foliage.* On the other hand, sulfur dusts neither injured the foliage nor russeted the fruit. If kept covered with the sulfur dust, the leaves grow normally and develop a dark green color. *Sulfur dust is cheap and is the only dust that has shown itself worthy of further trial.* It is possible that the copper-lime-arsenate dust may prove useful for the pre-pink and pink applications, to be followed with sulfur dust for the later applications. This combination will be tested another year.

In the Stowe and Marshall orchards there were no experimentally sprayed plots to compare with the dusted plots, but if we may judge from the results which these orchardists obtained on sprayed trees adjacent to the dusted plots, the sulfur dust was equal to the sprays.

#### THE EFFECT OF APPLE SCAB ON THE VITALITY OF THE TREE.

The most striking example of what may be expected of an unsprayed McIntosh orchard may be seen on the check plot in Knights orchard (Table V, plot 1). The trees of this plot have not been sprayed with a fungicide since 1920, and in 1921 and 1922 they showed approximately 100 per cent infection of fruit and foliage. The heavy loss of foliage in 1921, in spite of the fact that the trees were fed heavily, caused a very light set of leaves and blossoms in the spring of 1922, and consequently a greatly reduced yield of fruit. Plots 1 and 2, Table V, are located side by side in the orchard. It is planned to shift the check plot in this orchard from its present location to some other part of the orchard in 1923, as permanent injury to the trees is feared.

#### THE RELATION OF WEATHER TO SPRAYING.

Spraying should always be done in advance of rain periods, since the fungicide must be on the leaves in advance of the germination of the spores. If allowed to dry thoroughly, efficient sprays do not wash off sufficiently to destroy their fungicidal value. By studying the low barometric areas of the daily weather reports, the grower should be able to predict, with some degree of accuracy, weather conditions two to three days in advance.<sup>1</sup>

#### BURNING OF APPLE FOLIAGE BY SPRAYS AND DUSTS.

The foliage of some of the apple trees in the plots was badly burned with lime-sulfur during 1921, while in 1922 very little injury from this material was noticed. The writer believes that weather conditions were

<sup>1</sup> These daily reports may be obtained by addressing the United States Weather Bureau, Boston, Mass.

largely responsible for this difference. Temperature and humidity were quite high when many of the applications were made in 1921, while to a certain extent the opposite was true in 1922. *Apples should never be sprayed when temperature and humidity are both high, as burning of foliage is almost certain to result.*

The amount of spray applied does not seem to be as important a factor in burning the foliage as was formerly thought. In 1922 the writer selected trees in several plots in the Sabine and Knights orchards and thoroughly drenched them with the spray at the pink and calyx applications. At the end of the season the trees showed only slight injury.

Sulfur dusts have never burned the foliage, while burning from copper-lime dust is frequent.

#### RECOMMENDATIONS FOR 1923.

##### *Spraying Program.*

It should be borne in mind that the spray schedule which follows is based on only two years of experimental work, and therefore is subject to change. Where two or more spray materials are given, the first is preferable and should be used whenever possible.

*Delayed-dormant.* — Fifteen pounds of dry lime-sulfur dissolved in 50 gallons of water, or 1 gallon of liquid lime-sulfur in 9 gallons of water.

*Pre-pink.* — A 3-10-50 home-made Bordeaux mixture, or 3 to 4 pounds of dry lime-sulfur dissolved in 50 gallons of water, or 1 gallon of liquid lime-sulfur in 49 gallons of water.

*Pink.* — A 3-10-50 home-made Bordeaux mixture, or 3 to 4 pounds of dry lime-sulfur dissolved in 50 gallons of water, or 1 gallon of liquid lime-sulfur in 49 gallons of water.

*Calyx.* — Three to 4 pounds of dry lime-sulfur dissolved in 50 gallons of water, or 1 gallon of liquid lime-sulfur in 49 gallons of water.

*Fourth and Fifth Summer.* — Same as the calyx. Unless the rainfall of June, July and August is above normal, the fifth summer spray may not be necessary for the control of scab. On the other hand, if these months are rainy and scab is bad, the fifth summer application will be found very profitable.

Three-eighths of a pint of 40 per cent nicotine sulfate to each 50 gallons of spray is used at the delayed-dormant, pink and calyx applications. Also, 2 pounds of powdered lead arsenate to each 50 gallons of spray are used at the delayed-dormant, pink, calyx and fourth summer applications.

##### *Dusting Program.*

If a dusting program is to be followed, the delayed-dormant spray should be applied. *Dusting sulfur* should be used for the *pre-pink* and for all applications after the fourth summer dust. A dust composed of 90 parts sulfur and 10 parts arsenate of lead should be used for the pink; an 85-15 dust for the calyx and fourth summer applications. In case

sucking insects are bad, it will be necessary to spray the trees with three-eighths pint of 40 per cent nicotine sulfate in 50 gallons of water, or dust the trees with a commercial nicotine dust.

#### *Miscellaneous.*

Dry lime-sulfur passes through the spraying outfit better if it be allowed to stand in water about forty minutes before it is poured into the spray tank. Before going to the orchard with each tank of spray material, it is a good plan to weigh out the desired amount for the next tank in a 5 or 6 gallon pail, pour water over it and agitate with a wooden paddle for a few minutes. On returning, the spray tank is filled about two-thirds full of water, the agitator set in motion, the lime-sulfur from the pail poured into the tank, and the tank filled with water. Some growers consider soaking of the material unnecessary before putting it into the tank.

Lime-sulfur should be well agitated before it is applied to the trees as a too concentrated solution will burn the foliage.

Twelve-year-old trees with a height and spread of approximately 20 feet should receive about 4 gallons of spray material with each application.

Follow the spraying system outlined for 1921.<sup>1</sup> It is better to spray against the wind than with it, as less spray materials are wasted and a better covering is obtained.

The engine and duster of the dusting outfit should be on a low wagon or truck built especially for the purpose, so that the operator may shoot the dust upward through the tree. Special effort should be made to hit the extreme tops of the trees. Best results are obtained by giving the hose of the duster a quick circular or an up-and-down movement so as to hit all parts of the tree. Dusting should be done only when the surfaces of the leaves are moist. At least two sides of the trees should be dusted. On trees twelve to fifteen years old, approximately  $1\frac{1}{2}$  pounds of dust should be used on each tree at each application.

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<sup>1</sup> Extension Circular, "Apple Scab and its Control." This may be obtained by applying to Extension Service, Massachusetts Agricultural College.

## TABULATED RESULTS.

Tables IV to VII give briefly the results on the sprayed and dusted plots in each of the orchards during 1922.

TABLE IV.—*Results on the Sprayed Plots in Sabine Orchard.*

| Plot. | TREATMENT.                                                     | Clean Fruit<br>(Per Cent.) | Scab<br>(Per Cent.) | Marketable<br>Fruit<br>(Per Cent.) | Russetted<br>Fruit<br>(Per Cent.) |
|-------|----------------------------------------------------------------|----------------------------|---------------------|------------------------------------|-----------------------------------|
| 1     | Check, arsenate and nicotine only .                            | 0                          | 100                 | 5                                  | 0                                 |
| 2     | Home-made Bordeaux (pink) and liquid lime-sulfur.              | 84                         | 16                  | 98                                 | 0                                 |
| 3     | Home-made Bordeaux (pink) and dry lime-sulfur.                 | 49                         | 51                  | 90                                 | 0                                 |
| 4     | Liquid lime-sulfur . . .                                       | 86                         | 14                  | 97                                 | 0                                 |
| 5     | Dry lime-sulfur, 4-50 . . .                                    | 86                         | 14                  | 95                                 | 0                                 |
| 6     | Liquid lime-sulfur plus lime . .                               | 76                         | 24                  | 91                                 | 0                                 |
| 7     | Home-made Bordeaux (pre-pink and pink) and liquid lime-sulfur. | 81                         | 19                  | 96                                 | 0                                 |
| 8     | Home-made Bordeaux . . .                                       | 87                         | 13                  | 97                                 | 52                                |

TABLE V.—*Results on the Sprayed and Dusted Plots in Knights Orchard.*

| Plot. | TREATMENT.                                                     | Clean Fruit<br>(Per Cent.) | Scab<br>(Per Cent.) | Marketable<br>Fruit<br>(Per Cent.) | Russetted<br>Fruit<br>(Per Cent.) |
|-------|----------------------------------------------------------------|----------------------------|---------------------|------------------------------------|-----------------------------------|
| 1     | Check for plots 1 to 7, arsenate only .                        | 4                          | 96                  | 31                                 | 0                                 |
| 2     | Home-made Bordeaux (pink) and liquid lime-sulfur.              | 98                         | 2                   | 100                                | 0                                 |
| 3     | Home-made Bordeaux (pink) and dry lime-sulfur.                 | 97                         | 3                   | 99                                 | 0                                 |
| 4     | Liquid lime-sulfur . . .                                       | 96                         | 4                   | 99                                 | 0                                 |
| 5     | Dry lime-sulfur, 4-50 . . .                                    | 92                         | 8                   | 97                                 | 0                                 |
| 6     | Liquid lime-sulfur plus lime . .                               | 93                         | 7                   | 99                                 | 0                                 |
| 7     | Home-made Bordeaux (pre-pink and pink) and liquid lime-sulfur. | 99                         | 1                   | 100                                | 1                                 |
| 8     | Home-made Bordeaux . . .                                       | 87                         | 13                  | 95                                 | 47                                |
| 12    | Check for Bordeaux and dusts only .                            | 0                          | 100                 | 1                                  | 0                                 |
| 13    | Sulfur dust . . .                                              | 84                         | 16                  | 97                                 | 0                                 |
| 14    | Copper-lime-arsenate dust . . .                                | 93                         | 7                   | 99                                 | 22                                |

TABLE VI.—*Results on the Sprayed and Dusted Plots in Frost Orchard.*

| Plot. | TREATMENT.                                                      | Clean Fruit<br>(Per Cent.) | Scab<br>(Per Cent.) | Marketable<br>Fruit<br>(Per Cent.) | Russeted<br>Fruit<br>(Per Cent.) |
|-------|-----------------------------------------------------------------|----------------------------|---------------------|------------------------------------|----------------------------------|
| 1     | Check for plots 1 to 11, arsenate and nicotine only.            | 59                         | 41                  | 90                                 | Negligible.                      |
| 2     | Home-made Bordeaux (pink) and liquid lime-sulfur.               | 100                        | 0                   | 100                                | Negligible.                      |
| 3     | Home-made Bordeaux (pink) and dry lime-sulfur.                  | 99                         | 1                   | 100                                | Negligible.                      |
| 4     | Liquid lime-sulfur . . .                                        | 98                         | 2                   | 99                                 | Negligible.                      |
| 5     | Dry lime-sulfur, 4-50 . . .                                     | 98                         | 2                   | 100                                | Negligible.                      |
| 6     | Liquid lime-sulfur plus lime . . .                              | 90                         | 10                  | 98                                 | Negligible.                      |
| 7     | Home-made Bordeaux (pre-pink and pink) and liquid lime-sulfur.  | 99                         | 1                   | 100                                | 1                                |
| 8     | Home-made Bordeaux . . .                                        | 100                        | 0                   | 100                                | 13                               |
| 9     | Dry lime-sulfur, 4-50, on pre-pink, pink, etc.                  | 100                        | 0                   | 100                                | Negligible.                      |
| 10    | Dry lime-sulfur, 3-50 . . .                                     | 96                         | 4                   | 98                                 | Negligible.                      |
| 11    | Dry lime-sulfur, 3-50 (lead and lime-sulfur put on separately). | 96                         | 4                   | 100                                | Negligible.                      |
| 12    | Check for plots 13 and 14 . . .                                 | 34                         | 66                  | 68                                 | Negligible.                      |
| 13    | Sulfur dust . . . .                                             | 89                         | 11                  | 96                                 | 0                                |
| 14    | Copper-lime-arsenate dust . . .                                 | 86                         | 14                  | 97                                 | 13                               |

TABLE VII.—*Results on the Dusted Plots in Stowe and Marshall Orchards.*

## STOWE ORCHARD.

| Plot. | TREATMENT.                                                        | Clean Fruit<br>(Per Cent.) | Scab<br>(Per Cent.) | Marketable<br>Fruit<br>(Per Cent.) | Russeted<br>Fruit<br>(Per Cent.) |
|-------|-------------------------------------------------------------------|----------------------------|---------------------|------------------------------------|----------------------------------|
| 12    | Check for 25-year-old trees, sprayed with lead and nicotine only. | 15                         | 85                  | 48                                 | 0                                |
| 13    | Sulfur dust, 25-year-old trees . . .                              | 74                         | 26                  | 92                                 | 0                                |
| 14    | Copper-lime-arsenate dust, 25-year-old trees.                     | 87                         | 13                  | 97                                 | 21                               |
| 12    | Check for 12-year-old trees, sprayed with lead and nicotine only. | 16                         | 84                  | 46                                 | 0                                |
| 13    | Sulfur dust, 12-year-old trees . . .                              | 83                         | 17                  | 96                                 | 0                                |

## MARSHALL ORCHARD.

|    |                                             |    |    |     |    |
|----|---------------------------------------------|----|----|-----|----|
| 12 | Check, sprayed with lead and nicotine only. | 56 | 44 | 96  | 0  |
| 13 | Sulfur dust . . . .                         | 84 | 16 | 99  | 0  |
| 14 | Copper-lime-arsenate dust . . .             | 93 | 7  | 100 | 26 |





